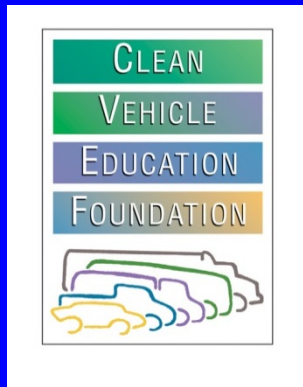


CNG Temperature Compensation and Pressure Management

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Technology Forum



Clean Vehicle Education Foundation

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CVEF CNG Safety Technology

- Safety educational materials, bulletins
 - www.Cleanvehicle.org
- Assistance in incident investigations
- Regulations, Codes and Standards (RCS) support
- Critical Technology Issues and Task Groups to address
 - Natural gas releases and facility safety
 - Quick action on overfilling of CNG vehicles
 - Long-term strategy for CNG overfill control
 - Cylinder valve issues
 - Pressure activated PRDs
 - Guidance for PRD selection and installation

Why Temperature Compensate (T-C)?

- Establish a safe maximum state of charge (SOC)
 - Simple pressure-based control is not adequate in the US
 - Vehicles refuel cold and then warm up
 - Exceeding maximum SOC has resulted in serious incidents
- Prevention of rupture in fire requires a maximum SOC

Excess Pressure if Filled Without Temperature Compensation

Gas Temperature, Pressure, psig

110 F 8,775

70 F 7,415

-40 F 3,600

80 F 5,449

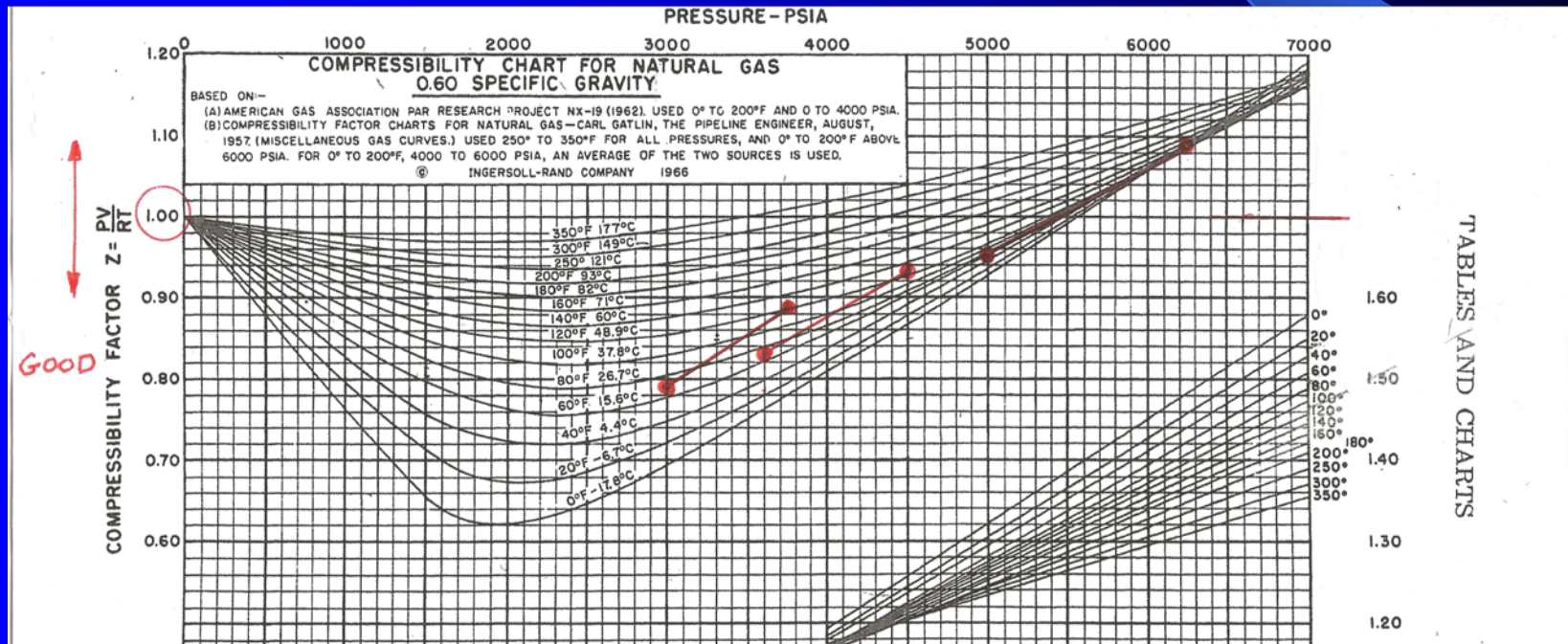
70 F 5,200

14 F 3,800

Why is Temperature Compensation Hard?

- The need for T-C is very counter-intuitive
- Natural gas is not an ideal gas and variable in composition
- The gas heats up as the container is filled
- The piping and container materials affect the degree of heating
- No national AHJ or standard for T-C
- **But why does it not work?**
 - Heating during filling prevents a full fill at moderate ambient temperatures higher than about 40F

Natural Gas is Far From Ideal



Why Is T-C More Important Now?

- Advanced dispensers eliminated the accidental margin
- Increasing reports of overfills
- Uncorrected and failure-prone container valves cause overfill
- Rupture disc PRDs increase the severity of consequences for marginal overfills
- Lightweight cylinders are less tolerant of overfill
- Economically driven fleets crave range
- Charge cooling can increase the overfill threat

What to Do?

- CVEF critical issues initiative
- Establish a national standard and regulation for temperature compensation
- Require on-board vehicle control against overfilling or;
- Require data exchange from vehicle to station
- Require on-board diagnostics and consequences for valve failure
- Or, eliminate the use of container valves
- Limit or eliminate the use of rupture disc PRDs
- Pre-cool the gas charge as practiced for CNG bulk transport and overseas transit buses